DELAWARE AIR NATIONAL GUARD

MID-AIR COLLISION AVOIDANCE

NEW CASTLE COUNTY AIRPORT

166TH AIRLIFT WING

24 MAY 2006

MEMORANDUM FOR ALL AIRCREW 24 May 2006

FROM: 166 AW/SE

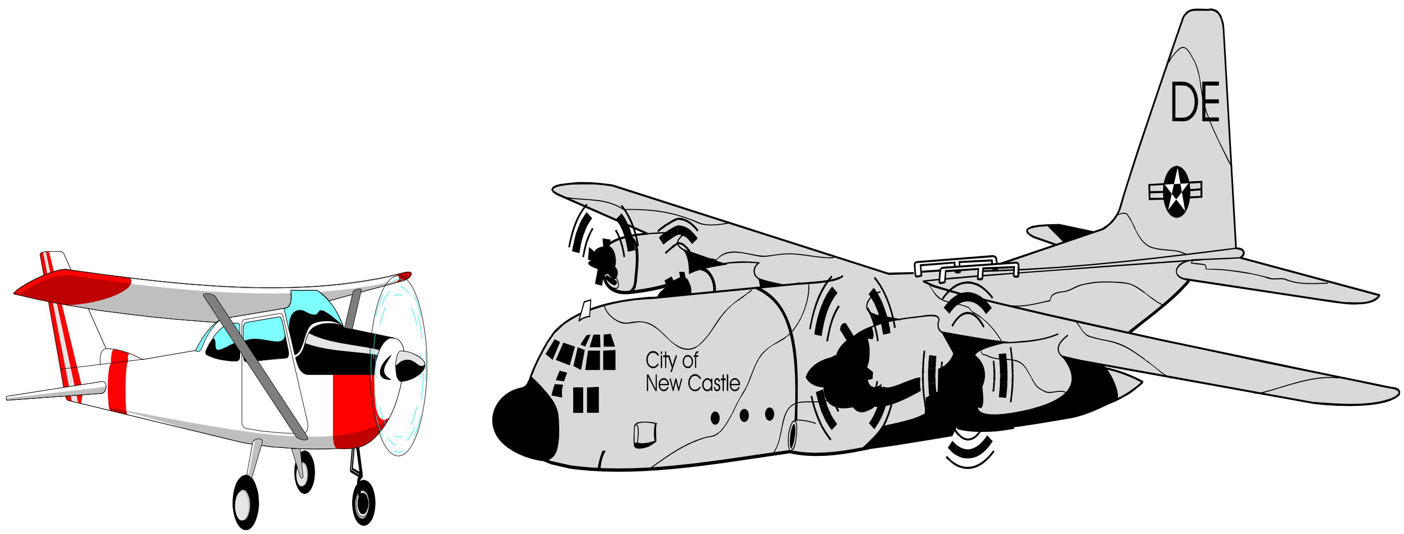
SUBJECT: Mid-Air Collision Avoidance (MACA)

1. Mid-Air Collisions are an area of great concern in aviation safety. They are unlike other types of aircraft accidents in that almost 50 percent of all cases, there is at least one death.

2. In order to prevent this type of tragedy, we have prepared this pamphlet. Part I describes the "See and Avoid" concept and provides positive suggestions to help you increase available protection. Part II is a description of our C-130 operations in Delaware, Pennsylvania, Maryland and New Jersey.

3. Please visit http://www.denewc.ang.af.mil/maca.maca.htm or www.seeandavoid.org for additional Delaware Air National Guard MACA information. If you have any questions, please contact the Safety office at (302) 323-3522.

//SIGNED//
CRAIG M. CONRAD, MAJ, DE ANG
Chief of Safety



SEE AND AVOID

Mid-air collisions are an area of great concern in aviation safety. They are unlike other types of aircraft accidents in that in almost 50 percent of all cases, there is at least one death.

With the sky becoming more and more crowded, and with aircraft flying at higher speeds, it is conceivable that the problem of preventing mid-air collisions will be worse in the future. The most often probable cause of the mid-air collision cited by the National Transportation Safety Board is "pilot in command failed to see and avoid other aircraft." The speeds of aircraft today strain our see and avoid procedures to the limit.

Mid-air collisions occur generally during daylight hours. Fifty-six percent of the accidents occurred at night, dusk and dawn. Most occurred in weather conditions when the visibility was acceptable, i.e., three miles or more.

The average flight time prior to the collision is 45 minutes. However, this time varies from takeoff to over seven hours. Sixty percent of these pilots on the fateful flight had been airborne 30 minutes or less. In fact, 32% had been up only 10 minutes or less. <u>Eighty percent had been up one hour or less.</u> Only 6% had been flying longer than two hours.

It would appear that fatigue is not a major factor in mid-air collisions, at least fatigue from the flights that the accident occurred. However, this does not eliminate the possibility of the pilot being fatigued prior to takeoff. Lets take a look at some of the techniques for preventing two aircraft from trying to occupy the same space at the same time:

DETECTION

The detection of an airborne object depends on six conditions: (1) IMAGE SIZE-the portion of the visual field filled by the object; (2) LUMINANCE-the amount of brightness of the object; (3) CONTRAST-the difference between the object and the background brightness, color, and shape; (4) ADAPTATION-the degree to which the eyes have adjusted to surrounding illumination; (5) MOTION-the velocity of the object, the observer, or both; (6) EXPOSURE TIME-the length of time the object is exposed to view.

(1) IMAGE SIZE

An aircraft seen at a long range appears not as an identifiable shape but rather as a dark dot. Aircraft detection is different under conditions of day and night vision. During the day, the further from the fovea (center of vision) the object falls, the larger the images must be in order to be noticed. At night, on the other hand, detection is sometimes superior if, the target image falls on the peripheral retina, (off center), rather that the fovea. The well-known phenomenon of a dim light disappearing when the observer looks directly at it and reappearing when he/she looks slightly to the side of it shows this.

(2) LUMINANCE AND (3) CONTRAST

Luminance and contrast are basically one in the same. An object will be visible then, only when it is sufficiently brighter or darker than its background-when, in other words, there is enough contrast.

(4) ADAPTATION

The eye requires at least 30 minutes, but sometimes much longer, in darkness to regenerate visual purple so that the eye can distinguish objects under low illumination. Conversely, when the eyes have been accustomed to darkness, they need to apdapt to bright light.

(5) MOTION

Against a stationary irregular background, an aircraft needs only to move a few minutes of arc per second to reveal its presence to an alert observer. Against a featureless background, like a cloudless blue sky, however, the aircraft's perceived motion must be 10 times faster to be noticed. What complicates the detection of relative motion is the fact that the eyes themselves are constantly moving.

(6) EXPOSURE TIME

An aircraft that darts in a out of clouds presents a special challenge to the viewer. When and aircraft is not continuously exposed to view, the pilot has to judge its speed and direction in order to follow its path behind cloud or horizon. A small, slow-moving object that presents little contrast against its background can be easily lost during intermittent observation.

VISION

As a person’s eyes become fatigued, they grow less efficient at the task of seeing airborne aircraft. Only well rested eyes can ensure good vision.

Structural parts, windshield/canopy distortion, poor cockpit lighting, and instrument glare can limit a pilot's vision. Make your windsheild spotless.

Total darkness, fog, total overcast, and cloudless blue skies, all present the viewer with a monotnous field. <u>In such conditions, normal eyes constantly try to focus on infinity by actually focusing on a point 1 to 2 meters away.</u> This is called search myopia and reduces the pilot's chances of seeing a distant aircraft.

ADVICE: Try to focus on objects at the maximum range you expect to see aircraft - focus on the ground at about 4 to 8 NM and move your gaze up to the sector of the sky to be searched. Avoid, as much as possible, frequent refocusing in and out of the cockpit.

About 1/3 of a second is required for the eye to focus at each fixation. Your airborne searching scan should be slow and methodical. Learn to scan the visual field by dividing the area up into sectors, about 30 degrees each. Fix your gaze in that sector for a second or two. Investigate any movement then move to the next sector. If you have trouble focusing at long ranges, try squinting. Squinting compresses the eyeball and changes its focal length, making long-range aircraft come into focus.

At lower altitudes the easiest aircraft to see is on the horizon. Shadows sometimes help pilots to detect another aircraft. To spot the aircraft, look from the shadow to the sun. The lower the aircraft is the closer it will be to its shadow.

RADAR

Radar myth and conception; the airman's concept of radar and what it can and cannot do for them.

The Continuing development of more sophisticated and automated equipment has given rise to the notion among some airmen that controllers are watching their every move enroute, and will always be able to warn other aircraft - particularly those flying IFR - or their presence. <u>This is the misconception that can kill you.</u>

The adoption of radar into air traffic control, ground clutter became an increasingly serious problem for terminal radar. Some of today's most sophisticated black box circuitry is aimed at reducing this phenomenon. Modern radar does a magnificent job compared to the old days, but clutter is still there. One way of reducing it to a minimum results in weakening radar's sensitivity to certain distant aircraft targets. The person affected in this trade-off is the airman flying an airplane whose radar - reflecting properties are weakest. This group includes many small general aviation airplanes flying IFR without active transponders. In some situations, these aircraft are not "painted" on the radarscope, even though they are within range of the transmitter.

SECURITY BLANKET

Some pilots think of IFR as a security blanket. They say to themselves, "I'm on an IFR flight plan; therefore, the air traffic service is going to tell me about all the traffic I might encounter." So they settle back in their seat in imagined safety.

WHO IS RESPONSIBLE?

The fact is that when operating in VMC conditions, regardless of flight plan, <u>responsibility for seeing and avoiding other traffic rests with the pilot</u>, not the controller. Civilian radar was developed primarily for the separation of IFR traffic from other IFR traffic. That is still the controller's prime responsibility, although he will also assist VFR traffic as much as time and facilities permit, calling the pilot's attention to any known potential problems or immediate hazard. Radar advisory service for aircraft is specifically designated as a duty that follows the priorities of separation, safety advisories and other required controller actions, to be performed on a workload permitting basis only.

What about VFR day when you were level at 4,500 - certainly high enough to be in coverage - and center missed telling you about the aircraft that nearly hit you? Traffic was light, so you know the controller should have had time to help you.

There are days when the weather is "good" for flying, but maybe not so good as far as radar is concerned. Wind, temperatures aloft (particularly when inversions are present), dew point spread and clouds all have effects on radar that produce clutter, or reduce radar efficiently. This may occur where you or your traffic is located. In addition, the angle at which the radar antenna is tilted can result in some traffic not being seen at certain altitudes. Statistics show that the bulk of IFR traffic, the kind Center radar is primarily interested in, spends most of its time at relatively high altitudes while enroute. This is the traffic that the enroute radar is designed to monitor.

In terminal areas, the heavy traffic areas are within 30 miles of the airport at altitudes varying with the location; again, the radar is focused for the area of greatest use. At 40 miles out you are in all likelihood within range of the radar signals, <u>but the controller's scope may only be displaying targets closer in.</u> Another factor to keep in mind is that there is virtually always a cone of non-coverage directly overhead the radar antenna. All these things leave some rather wide-open air spaces where there is no VFR radar coverage available at many altitudes.

Certain kinds of general aviation aircraft are detected by radar with more difficulty than others. Smaller airplanes; those made in great part of materials other than metal; aircraft without propellers; and slow moving aircraft have less reflecting ability than others, resulting is less return of energy to the radar antenna. Consequently, the primary targets they produce are weak or often non-existent. An airplane also presents less of a target to the controller when it is flying directly toward, or directly away from, the radar antenna.

WEATHER RADAR

One of the current uses of radar, other than air traffic control, is in weather observations and forecasting, and weather returns tend to blot aircraft. True, controllers can lessen to some extent the strength of weather returns, but this ability is not absolute and often it is desirable to display weather for use when airmen ask to be vectered around rough areas or storm cells. Other aircraft may be "wiped off the scope" by this display.

100 PERCENT CONCEPT

The concept of 100 percent radar coverage has to be understood in terms of stated goals, present and future. Questions put to FAA "Listening Sessions" reveal that some pilots believe any time they hear "Radar Contact", the controller has taken over all separation responsibilities. At the very least, these pilots believe all air traffic in the area is shown on the controller's scope. This assumption can be a fatal error. Radar does not protect from unidentified aircraft or those that may not be showing up clearly on the radar scope, such as VFR traffic that has entered into an IFR environment.

Radar advisories are an infinitely useful aid in helping the VFR pilot maintain separation, but they are not to be regarded as evidence that a controller has taken over responsibility for such separation.

INCREASE AVAILABLE PROTECTION

What can the airman do to increase the protection available for radar?

Much of the problem could be solved by the acquisition and use of a transponder. The difference between a non-transponder equipped light aircraft (a small dot) and a transponder equipped aircraft (a "slash" many times the size of the small dot) would surprise you. Transponders make the size of the airplane irrelevant; transponder replies are the same size for a 747 and for a Super Cub.

If you have a transponder, particularly with mode C altitude reporting, use it. Many pilots turn the transponder off when leaving the terminal areas to "save" it or lengthen its operating life. There are two dangers in this practice: One is the weaker reply enroute that makes you less visible on the controller's scope and the other is the possibility of forgetting to turn it back on at your destination area.

You can help the radar controller help you by not adding to their workload unnecessarily when they're in the process of identifying your target. Remember that they may be looking at many unidentified blips on the scope. Knowing where you are at all times simplifies the task of establishing radar contact - and shortens the time when you are present as an " unknown ".

VFR and IFR flight use similar concepts. Maintaining IFR means adhering to IFR altitudes and airspeeds, while remaining within defined airspace, such as the enroute structure or terminal area and making the most of any traffic separation service available. When VFR, we still remain within certain airspeed, altitude and area perimeters, such as in the traffic pattern and VFR hemisphere altitude.

Aircraft operating in visual conditions under IFR should be aware that they are in a "see and avoid" environment. Separation is provided only from other known aircraft operating within controlled airspace.

Use extreme caution in terminal areas. This is where traffic density is greatest, and where the mix of IFR and VFR condition is fine, but it's not the time to keep your eyes glued to the gauges, including E/TCAS screens. Even a radar monitor may not help. There are a lot of non-transponder equipped aircraft around that may not appear on the controller's scope. Don't get complacent, not even on final.

LISTEN

If you can't look, listen. Recent improvements in the U.S. Air Traffic Control system such as E/TCAS have made life a little safer for everybody, but any system has flaws. In IMC, pay attention to the radios and keep up with the traffic situation in your area.

1968 FAA (NMAC) REPORT

The 1968 FAA Near Midair Collision (NMAC) Report established that the majority of the 2230 NMAC reports investigated were found to have occurred within the terminal airspace environment. Military aircraft were involved in 27% of all incidents, air carriers 30%, and general aviation 43%. Within the terminal airspace, 30% of the NMAC occurred within 5 NM at or below 3500 feet AGL, and 97% within 30 NM at or below 8000 feet AGL.

Nearly half of the incidents involved an aircraft approaching the aircraft in climb or descent altitude encountering another aircraft in level flight. The second aircraft was generally operating on an IFR flight-plan, both were usually in VFR conditions.

Within enroute airspace, 67% of the NMAC occurred below 10,000 feet MSL. Nearly 40% of the total were within 10 miles of a NAVAID.   This converging situation is considered the most significant factor in the enroute airspace.

Although general in nature, the following list identifies the human, equipment and environment sources of near midair collisions:

1. Human factors.
2. Aircraft mix - IFR/VFR.
3. See and Avoid.
4. Communications
5. Airport location
6. Airspace utilization.
7. Lack of Collision Avoidance System.

Increased radar advisory service may reduce the airman's motivation to keep a "lookout" and cause a further breakdown of the "see and avoid" concept.

A 1974 study by the Mitre Corporation for the FAA listed the most significant contributing factors to IFR-VFR midair and near midair collision as:

1. No surveillance data on the other aircraft.
2. No altitude data on the other aircraft.
3. ATC responsibility split between two controllers.
4. Pilot/crew factors.

2

(NMAC = V_t 2) = (E = T)

A theoretical formula developed from the Journal of the Institute of Navigation shows that: The potential for near midair collisions is squared as the volume of traffic in a given area increases or NMAC = (Vol. Of Traffic)^{2}. This means, if the air traffic doubles the number of near midair's will be multiplied by four.

Air traffic is forecast to continue to increase. Although military operations are expected to remain relatively stable, the rise in general aviation activity may be substantial.

The message is clear, if we are to avoid an increase in midair collisions in the future, our efforts must also be increased in proportion to the square of the traffic E = T^{2}.

IN CONCLUSION

An aviator is more likely to detect an aircraft…

*The larger it is.
*Daylight, the closer it falls on the center of vision
*Evening, detection may be better if the image is on the peripheral retina (off center).
*The more it contrasts with its background
*In brightness; i.e., a dark aircraft against a white cloud.
*In color; i.e., a yellow airliner against a blue sky.
*In shape; i.e., a side view of an aircraft rather than a head on view.
*The more adapted the eyes are
    -Adaptation to light takes about 10 minutes from darkness to moderate lighting.
    -Adapting to dark takes at least 30 minutes, from bright sunlight to darkness.
*Generally the faster the aircraft moves, however, very fast aircraft cannot be clearly recognized.
*The greater the change in aircraft speed
*The less the head and eyes move (rapid scanning reduces the ability to discern the aircraft's relative motion)
*The longer the aircraft remains in the field of view.

- Understand the limitations of radar.
- Help controllers in helping you.
- Realize the VFR/IFR mix situation.
- Know where high traffic density areas are located.
- Along with "looking", "listen".
- The majority of midair's and near midair occur; near the airport, during day VFR weather, within the first 30 minutes after takeoff and usually below 8,000 feet AGL.
- As the volume of traffic in a given area increases, the potential for a midair is squared: NMAC = (Volume of traffic)^{2}.

LOCATING THE BLIND SPOT

A. With the right eye closed, look at the right of the upper figure. Move the paper back and forth about one foot from the eye; the circle on the left will disappear. At that point it is projected on the blind spot.

B. With the right eye closed, look at the cross right of the lower figure. When the white space falls in the blind spot, the black line appears to be continuous. This phenomenon helps to understand why we are not ordinarily aware of the blind spot.

It is important to realize that all of us have a blind spot. The potential for a midair collision lies within this blind spot area. At one mile this area could be 800 feet by 500 feet and at 5 miles the area may be 4/5 of a mile. The blind spot will vary as to different types of aircraft and different face structures. A way to compensate for the blind spot is to move the head around while looking and look more than once in a given direction.

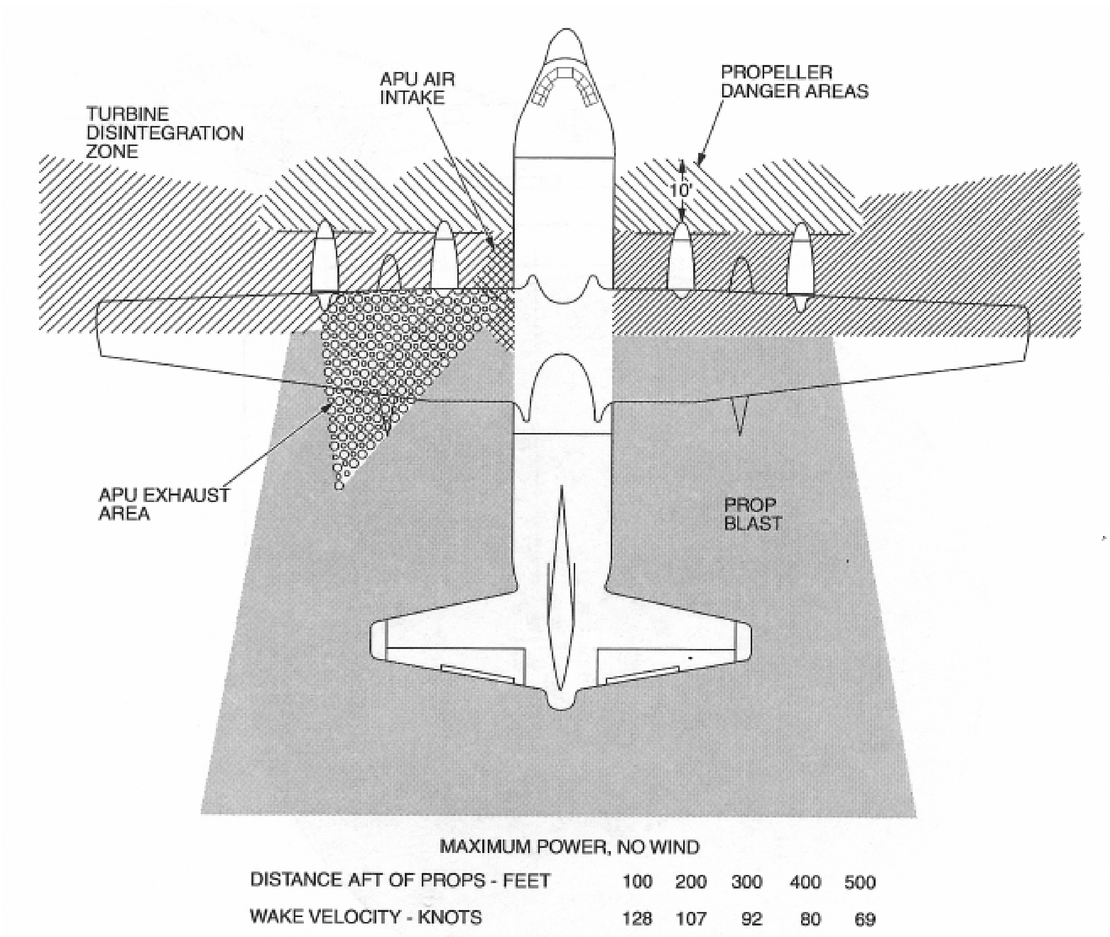
166 AIRLIFT WING

TYPE AIRCRAFT:	LOCKHEED C-130H2
CALL SIGN:	Local “HUSKY”, Cross Country “CARMEN”
DESCRIPTION:	HIGH WING, FOUR ENGINE TURBOPROP, HIGH ALTITUDE, MEDIUM RANGE MONOPLANE
COLOR:	USAF GRAY
DIMENSIONS:	LENGTH - 99 FT, HEIGHT - 38 FT, WINGSPAN - 133 FT
MAX GROSS WEIGHT:	155,000 LBS
MAX SEA LEVEL AIRSPEED:	288 KTS
FINAL APPROACH SPEED:	110 - 130 KTS
SERVICE CEILING:	35,000 FT
FORMATION FLIGHT:	OCCASIONALLY UP TO SIX AIRCRAFT

GROUND FACILITIES AND OPERATIONS

The 166th Airlift Wing is located on the northeast side of the New Castle County Airport. Because of the proximity to numerous small aircraft, taxi operations should be conducted with extreme caution.

C-130 runups present a potential hazard to light aircraft. The diagram on the following page indicates danger areas associated with the C-130 and the velocity of the prop blast associated with an aircraft under power.

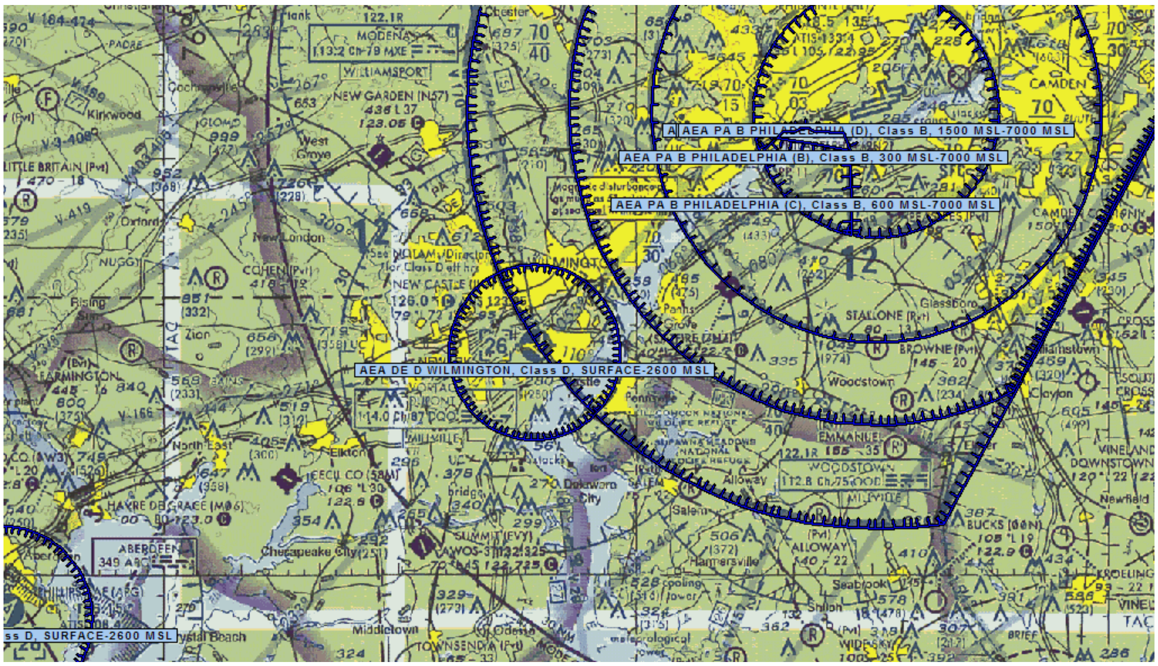


Occasionally, up to 6 aircraft will be taxiing in formation. The wake from this formation could prove hazardous and should be avoided.

AIRPORT OPERATIONS

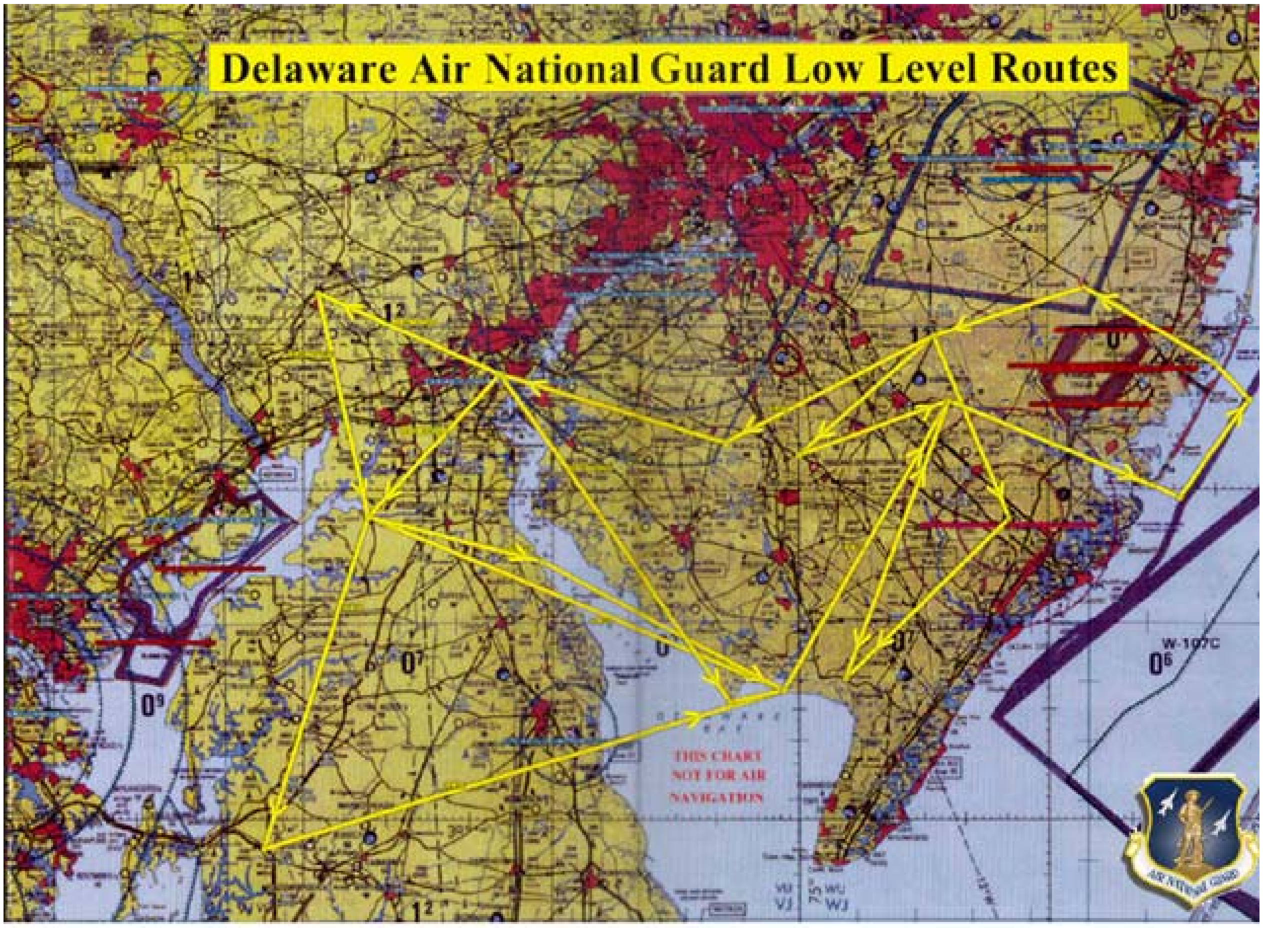
Although the 166th AW conducts most of its training away from the New Castle County Airport, several items pertaining to local area operations might prove helpful to general aviation operators.

Tactical VFR recoveries are normally conducted when returning as a formation to New Castle County Airport. This recovery requires an overhead approach. Initial is usually set up approximately 5 miles from the field at 2000 MSL and descending to 1600 MSL. Airspeed for the formation is 200 Kts IAS. As each aircraft passes over the approach end of the landing runway, the pilot will establish a 45 degree left or right bank and complete an overhead approach and landing. Regulations require that all aircraft use the entire length of the runway for stopping. The C-130 and especially a large formation of C-130s leave a great deal of prop wash in the vicinity of the runway, so beware of the wake turbulence. During normal landings, the C-130 can slow its approach speed to almost 100 Kts (depending on gross weight) so as to fit into the flow with traffic. Formation departures are conducted from New Castle County Airport. All aircraft in the formation will position on the runway prior to any aircraft taking off. Takeoff interval is 15 seconds. Formation lengths can vary from approximately 1 mile for a 2 ship to over 5 miles long for larger formations. Again, light aircraft operators should by cautious of the wake turbulence generated by the C-130s.



TACTICAL OPERATIONS

As an airlift wing, the 166th conducts, on a regular basis, tactical low level training. This training is conducted on low level routes in Maryland, Delaware, New Jersey and occasionally southeast Pennsylvania. Aircraft depart New Castle County Airport generally to the west at 2,000 Ft MSL and 210 Kts. The particular routing is either to the Bohemia River Bridge, the towers north of Oxford, PA or Canton, NJ at which time the aircraft descend to their low level altitude and maintain 210 Kts (plus or minus 10-15 Kts for timing control). The enroute altitude varies from 300 Ft AGL to 500 Ft above the highest obstruction on the particular leg of flight. The route is continued until arriving at the Coyle Drop Zone (at the Coyle Vortac northeast of Atlantic City) at which time they will slow to approximately 130 Kts to complete their "air drops". After the drops are completed, the aircraft will either recover at Atlantic City, NJ using a “tactical recovery” as described above or return to New Castle. Throughout these tactical VFR missions, the C-130 aircraft will be monitoring 343.0 UHF or the appropriate traffic advisory VHF frequency. The following page shows all of the low level routes which the 166th uses.



The 166th Airlift Wing, DE ANG, conducts military low-level VFR training on the above displayed SR routes.

Type of Aircraft: Lockheed C -130

Description: High Wing, Four - Engine Turboprop Monoplane

Color: USAF Gray Call Sign: Husky

Day and Time of Operations: Normally Tuesday, Wednesday, Thursday, and the First Weekend of the month (UTA / Drill); Hours are usually between 1000 - 1400 and 1900 - 2200 local.

Formation Size: Two to Six Aircraft (0.3 - 3.0 NM) in Length.

Enroute Altitudes Flown: 500 AGL to 3000 MSL.

DANGERS

WAKE TURBULENCE generated behind and below formation Aircraft and MID - AIR COLLISION!

Address All Inquiries to the DE ANG Base Operations at (302)323-3525 /3526 OR to the DE ANG Safety Office at (302)323-3522 /3520.

WAKE TURBULENCE

Wake turbulence is produced to some degree by all airplanes. A wing's lift causes a whirlpool or vortex to form behind the tip of each wing. The intensity of these vortices depends on the amount of lift being generated. When an aircraft is heavy, slow and clean (flaps and gear up), it generates the most wake turbulence. Tests have shown wake turbulence can reach vortex velocities of over 130 Kts. The vortex sinks 400-500 FPM until leveling off about 800-1000 Ft below the airplane.

At the present time, the only safe way to combat wake turbulence is to know and avoid areas where it is likely to be encountered. You should, therefore, avoid the area directly behind and below generating aircraft. Try to stay two or three minutes behind C-130's if you share the same traffic pattern and avoid the area 1 to 2 miles behind and 100 to 1500 feet below them.

THANK YOU AND FLY SAFE!